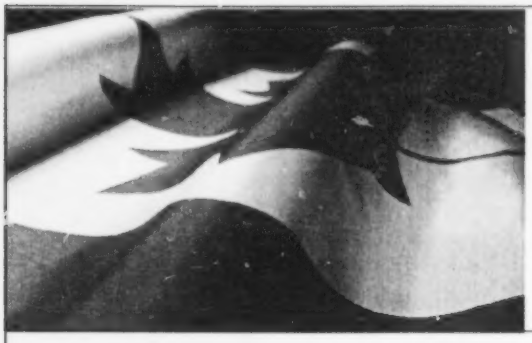

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Fiscal Planning in an Era of Economic Stability

by

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– Abstract –

Recent research has shown that the volatility of output growth and inflation has declined over time in Canada, and most other industrialized countries. This paper examines the implications for medium-term fiscal planning at the federal level in Canada.

We examine the performance of mean forecasts of output growth and inflation obtained from surveys of private sector forecasters in Canada and the US. The results indicate a substantial decline in forecast uncertainty since the mid-1980s. We then calibrate a stochastic simulation model to match the performance of private sector forecasts over the historical period. Stochastic simulation experiments are used to illustrate how varying the amount of uncertainty surrounding economic forecasts influences debt reduction outcomes.

The reduction in forecast uncertainty observed over the historical period is found to have a major impact on the dispersion of debt reduction outcomes when the fiscal planning framework involves multi-period commitments to tax and spending measures. The simulation results also demonstrate that keeping inflation stable and avoiding over-optimistic estimates of potential output growth help ensure that the debt-to-GDP ratio is kept on a clear, downward profile in the presence of uncertainty surrounding economic developments.

– Résumé –

Des recherches récentes ont révélé une réduction progressive de la volatilité de la croissance de la production et de l'inflation au Canada et dans la plupart des pays industrialisés. Dans le présent document, nous étudions les répercussions de ce phénomène sur la planification budgétaire à moyen terme dans l'administration fédérale au Canada.

Dans un premier temps, nous examinons la performance des prévisions moyennes liées à la croissance de la production et à l'inflation établies par des prévisionnistes du secteur privé au Canada et aux États-Unis. Les résultats démontrent une réduction marquée de l'incertitude dans les prévisions depuis le milieu des années 80. Dans un deuxième temps, nous calibrons un modèle de simulation stochastique afin de reproduire la performance des prévisions dans le

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secteur privé au cours de la période historique. Les expériences de simulation stochastique permettent d'illustrer l'influence de l'incertitude entourant les prévisions économiques sur la réduction de la dette.

Nous avons constaté que la réduction de l'incertitude dans les prévisions observée au cours de la période historique a une incidence majeure sur la dispersion de la réduction de la dette lorsque le cadre de planification budgétaire comprend des engagements sur plusieurs périodes à l'égard de mesures touchant les recettes ou les dépenses. De plus, les résultats de la simulation indiquent qu'en stabilisant l'inflation et en établissant des prévisions prudentes au chapitre de la croissance de la production, on peut faire en sorte que le ratio de la dette au PIB se maintienne fermement sur une pente descendante face à l'incertitude entourant les développements économiques.

1. Introduction

A number of recent papers have shown that the volatility of many macroeconomic variables has declined over time in several industrialized countries.[1] The timing roughly corresponds to the low and stable inflation environment that emerged in many countries in the early 1990s. For example, the standard deviation of annual nominal GDP growth in Canada declined from five per cent over the period 1973-1992 to two per cent over the period 1993-2000. Although it is premature to conclude that we are now in a new era of economic stability, it is nonetheless of interest to consider the policy implications. This paper investigates what it would mean for medium-term fiscal planning at the federal level in Canada.

The *Debt Repayment Plan*, introduced 1998 federal budget, aims to keep the federal net debt-to-GDP ratio on a clear, downward profile. The federal net debt-to-GDP ratio peaked at 70 per cent in 1996 and has subsequently declined to 50 per cent in 2001.[2] This was the result of strong economic growth, along with a fiscal planning strategy that includes an explicit amount of fiscal prudence to provide insurance against the risk of a deficit outcome. Lower volatility in economic variables such as output growth, inflation and interest rates would imply less uncertainty surrounding economic projections used in preparing the fiscal plan. As a consequence, a lower amount of fiscal prudence would be required to limit the risk of deficit outcome and thereby ensure that debt repayment continues in the future.

A number of existing studies have examined the question of how much fiscal prudence would be required to insure against the risk of running a deficit (Boothe and Reid 1998, Robson and Scarth 1999, Dalsgaard and De Serres 1999, and Hermanutz and Matier 2000). Some of these papers have taken into account the possibility that there have been changes in the amount of forecast uncertainty over the historical period. For instance, Hermanutz and Matier calibrate a stochastic simulation model such that the standard deviation of annual nominal income growth is 2.2 per cent, which is roughly consistent with the standard deviation

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[1] See Longworth (2002) and the references therein.

[2] All fiscal measures in this paper are defined on a national accounts basis.

observed in Canada over the period 1993-2000 (2.0 per cent). One would likely obtain quite different results if the model were calibrated to match the standard deviation of nominal income growth over the period 1953-2000 (4.3 per cent).

We contribute to this literature by developing a calibration methodology that corresponds more closely to measures of uncertainty surrounding the fiscal plan. In the current fiscal planning framework, estimates of tax revenues and fiscal expenditures are based on private sector forecasts of economic developments over the planning period. We calibrate a stochastic simulation model to match the performance of the private sector forecasters over the historical period. Stochastic simulation experiments are then used to examine how changes in the amount of uncertainty surrounding the fiscal plan influences debt reduction outcomes.

The plan of the paper is as follows. Section 2 examines the performance of private sector forecasts in Canada and the US over the historical period and describes the methodology used to calibrate the stochastic simulation model. Section 3 discusses the stochastic simulation results. The final section concludes by highlighting the main policy implications.

2. Measuring Uncertainty Surrounding Forecasts

This section of the paper seeks to gauge the amount of uncertainty surrounding private sector forecasts of economic variables that are of most importance for fiscal planning purposes, namely: output growth, inflation, and interest rates. The analysis focuses on the one-year forecast horizon so that we can assess the amount of uncertainty surrounding economic projections over the fiscal year. We first investigate the extent to which the amount of variation in output growth, inflation and interest rates has changed over the historical period in Canada and the US. We then examine whether there have also been changes over time in the amount of uncertainty surrounding forecasts of these variables by evaluating the forecasting performance of a simple autoregressive model and private sector forecasters over selected sub-periods.

2.1 Volatility

Table 1a reports standard deviations of output growth, inflation and interest rates in Canada calculated over different sub-periods.[3] These descriptive statistics provide a rough indication of how much the variation in each series has changed over time. The sample period 1953-2000 is split into two sub-periods defined with reference to two breakpoints: one corresponds to the productivity slowdown in 1973; the other breakpoint corresponds to the emergence of a low and stable inflation environment in 1993. Since the latter sub-period consists of only seven years, we also consider an alternative breakpoint: 1986, which divides the sample period 1973-2000 in half. Table 1b reports corresponding statistics for the US.

The top panel in Table 1a shows that the volatility of inflation and interest rates increased substantially between the sub-periods 1953-1972 and 1973-1992. This largely reflects the inflationary episodes in the 1970s. There is, however, little change in the volatility of real GDP growth over the two sub-periods. A similar pattern is observed in the US (shown in the top panel of Table 1b).

The middle panel in Table 1a shows that the volatility of output growth, inflation and interest rates in Canada declined substantially between the sub-periods 1973-1992 and 1993-2000. The standard deviation of real GDP growth, inflation and the short-term interest rate declined 1.5, 2.4 and 1.8 percentage points, respectively, over these two sub-periods. A similar pattern is observed in the US (shown in the middle panel of Table 1b). Note that "core CPI" inflation has been remarkably stable since the early 1990s, exhibiting a standard deviation of only 0.3 per cent in Canada and 0.4 in the US over the sub-period 1993-2000.[4]

The bottom panel in Table 1a indicates that the decline in the volatility of each variable is less apparent when the comparisons are made with reference to the 1986 breakpoint, instead of the 1992 breakpoint. In particular, the standard deviation of real GDP growth declines by

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[3] Output growth and inflation are measured as annual percentage changes; interest rates are annual averages. See the appendix for a detailed description of the data.

[4] "Core CPI" in Canada refers to the CPI excluding food and energy prior to 1984; the effects of indirect tax changes are also excluded beginning in 1984. "Core CPI" in the US refers to the CPI excluding food and energy.

only 0.7 of a percentage point with the 1986 breakpoint, versus 1.5 percentage points with the 1992 breakpoint. This indicates that estimates of the reduction in the volatility in each variable over time are sensitive to the breakpoint that is chosen. This is not the case for the US variables. The decline in the standard deviations calculated over sub-periods is similar with reference to the 1986 and 1992 breakpoints (shown in the middle and lower panels of Table 1b).

2.2 *Autoregressive Forecasts*

A simple autoregressive model is used to provide a benchmark measure of the amount of uncertainty surrounding forecasts of output growth, inflation and nominal interest rates. The time series properties of each variable was found to be well captured by a 1st-order autoregressive (AR1) process of the form:

$$(1) \qquad y_t = \alpha + \beta y_{t-1} + \varepsilon_t$$

where β is the autoregressive parameter and ε_t is a random error term. Estimates of β are empirically large and statistically significant for each variable except real GDP growth, indicating that real GDP growth exhibits little persistence (at the annual frequency), unlike inflation and interest rates.[5] This implies that a sizable component of movements in inflation and interest rates can be forecasted using their time series properties. For example, the simple AR1 model can explain between 65 to 75 per cent of the variation in inflation.[6]

We gauge the forecasting performance of the AR1 model by calculating root-mean squared errors (RMSEs) of forecasts over a one-year horizon.[7] The forecasts are generated using recursive estimates of the autoregressive parameters and hence, are based on information known at the time that they are made.[8] RMSEs of AR1 forecasts for output growth,

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[5] Estimates of the autoregressive model (1) for each variable are reported in Appendix 2.

[6] The R^2 reported in Appendix 2 represents the amount of variation in each variable that can be explained by the estimated AR1 model.

[7] RMSE = $[\Sigma \hat{e}^2]^{1/2}$ where $\hat{e} = y - \hat{y}$ is the forecast error and $\hat{y}$ is the one-year ahead forecast of y.

[8] The forecasts are generated using the most recent vintage of data and hence, do not take into account uncertainty arising form data revisions. We return to this issue later in the paper.

inflation and interest rate are reported in Tables 2a and 2b over the same sub-periods examined above.[9]

The top panel of Table 2a indicates that the performance of the AR1 forecasts for Canadian variables deteriorated somewhat between the sub-periods 1961-1972 and 1973-1992. For example, the RMSE of forecasts for real GDP growth increased by about 0.4 of a percentage point over the two sub-periods, while that for core CPI inflation increased by 0.7 of a percentage point. The middle panel indicates that the performance of the AR1 forecasts improved substantially between the sub-periods 1973-1992 and 1993-2000. For example, the RMSE of forecasts for real GDP growth declined by about 1.9 percentage points over the two sub-periods, while that for core CPI inflation declined by 2.0 percentage points.[10] The bottom panel in Table 3a illustrates the change in forecasting performance with reference to the 1986 breakpoint. In this case, the improvement in forecasting performance is less apparent for output growth, but similar for inflation. The RMSE of forecasts for real GDP growth declined by only 0.7 of a percentage point over the two sub-periods, while that for core CPI inflation declined by 2.4 percentage points. A similar pattern holds for AR1 forecasts of the US variables (reported in Table 2b). The results are, however, more robust with respect to the two breakpoints.

On the whole, the results obtained using forecasts generated by a simple autoregressive model indicate that the amount of uncertainty surrounding economic forecasts has declined substantially over time. The estimates obtained for Canada are, however, sensitive to the breakpoint selected.

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[9] Because the forecasts are generated using recursive estimates of the parameters, the RMSEs are calculated beginning in 1961 using the sample period 1953-1961 to get initial estimates of the parameters.

[10] Our results corroborate the findings of Braun and Babineau (2002), who examine forecasts of real GDP growth in Canada and the US generated by various univariate models. They find that the forecasting performance of all models improved significantly in the 1990s. For example, they calculate the RMSE of one-year ahead forecasts of real GDP growth over five-year intervals. They find that the RMSE for forecasts of real GDP growth in Canada declines from about 3 per cent for the five-year period ending in 1990 to about 1 per cent for that ending in 2000.

2.3 *Private Sector Forecasts*

We now examine the performance of mean forecasts obtained from surveys of professional forecasters in Canada and the US.[11] The survey data for Canada is obtained from the *Conference Board of Canada* publication *The Survey of Professional Forecasters* (SPF). The US survey data is obtained from the Federal Reserve Bank of Philadelphia, which publishes forecasts from the *Survey of Professional Forecasters* and the *Livingston Survey*. Our analysis focuses on the mean of all responses collected by the surveys.[12] We evaluate mean forecasts of annual percentage changes in real GDP, the GDP deflator and the total CPI over a one-year forecast horizon, as well as mean forecasts of interest rates over a one-year horizon.

The RMSE of mean forecasts for real GDP growth, inflation and interest rates are reported in Table 3. The sample periods vary with the availability of the survey data. There are over 25 years of survey data on forecasts of GDP growth and inflation in both countries, but only 19 years of survey data on interest rates in the US.[13] In each case the sample period is split in half and RMSEs are reported for each of the sub-periods.

Table 3 shows that performance of mean forecasts for each variable has improved over time. The RMSEs of mean forecasts for inflation declined markedly in the mid-1980s. The decline in RMSE of mean forecasts for real GDP growth is less apparent. For example, the RMSE of mean forecasts for CPI inflation obtained from the SPF in Canada declined by 1.75 percentage points in 1988, while that for real GDP growth declined by only 0.4 of a percentage point. There is small improvement in the performance of mean forecasts for US short-term interest rates in 1992, but little change in the performance of mean forecasts for long-term interest rates.

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[11] See the appendix for a detailed descriptive of the survey data.

[12] Similar results were obtained using *median*, rather than *mean*, forecasts collected by the SPF and Livingston surveys for the US.

[13] The SPF survey data in Canada are available beginning in 1975. The SPF survey data in the US are available beginning in 1969; the Livingston survey data are available beginning in 1972. We do not evaluate the private sector forecasts of interest rates in Canada because there are only 11 years of survey data available.

We examine whether the private sector forecasts have been biased on average. Mean forecast errors are reported in Table 4 for each variable.[14] There are several cases where the mean forecast error is large relative to the RMSE. For example, the mean SPF forecasts of real GDP growth in the US have a mean error of 0.64 of a percentage point over the sub-period 1985-2000, which is about half of the RMSE (1.3 percentage points). We also examine whether the forecast errors exhibit persistence.[15] We find evidence of autocorrelation in the forecast errors for many of the variables, particularly the inflation forecasts.

To sum up, our analysis of private sector forecasts suggests that the amount of uncertainty surrounding forecasts of output growth, inflation and interest rates declined in the mid-1980s. The decline is much more apparent for forecasts of inflation and short-term interest rates than for output growth and long-term interest rates. Moreover, our analysis also indicates that the private sector forecasts have been biased and the forecast errors exhibit significant persistence over some sub-periods. The next section of the paper examines the implications of these findings for fiscal planning.

3. Stochastic Simulation Experiments

We will not describe the structure of the stochastic simulation model used to generate our results due to space limitations.[16] We will discuss the calibration methodology that underpins the stochastic simulation experiments and then describe the fiscal planning problem before presenting the simulation results.

3.1 Calibration Methodology

The stochastic simulation model is calibrated to match the performance of the private sector forecasts outlined above. Forecasts generated by the model in the base case simulation

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[14] Mean error = $\Sigma\hat{e}$, where $\hat{e} = y - \hat{y}$ is the forecast error and $\hat{y}$ is the one-year ahead forecast of y.

[15] This entails estimating the OLS regression $\hat{e}_t = \rho\hat{e}_{t-1} + u_t$ where $\hat{e} = y - \hat{y}$ is the forecast error and then inferring whether the autocorrelation parameter ρ is empirically and statistically significant.

[16] The stochastic simulation model is documented in Hostland (2001).

experiments are unbiased and the forecast errors do not exhibit persistence. We consider the implications of biased forecasts and persistent forecast errors later in the paper.

The RMSEs of forecasts generated by the stochastic simulation model are reported in Table 5. The one- and five-year forecast horizons summarize the performance of the model over the short- and medium-term. Our discussion of the calibration methodology focuses on the amount of uncertainty surrounding forecasts of output growth, inflation and interest rates because these variables have the greatest influence on the fiscal plan. We also report RMSEs for forecasts of the budget balance and net debt (both expressed as proportions of GDP) to show how varying the amount of forecast uncertainty surrounding economic variables in the model impacts on the amount of uncertainty surrounding the fiscal plan. The amount of uncertainty surrounding forecasts generated by the model is presented with reference to a "base case" calibration, along with a "low" and "high" calibration that form a lower- and upper-bound for simulation experiments discussed later in the paper.

Output growth

Forecasts of real GDP growth generated in the base case calibration have a RMSE of 1.5 per cent over a one-year horizon, which closely corresponds to the RMSE of the mean SPF forecasts in Canada over the period 1975-2000 (reported in Table 3).[17] The low and high calibrations have a RMSE over the 1.3 to 1.7 per cent, respectively. This range of outcomes corresponds to the mean SPF forecasts for Canada evaluated over the sub-periods 1975-1987 and 1988-2000 (also reported in Table 3). Five-year-ahead forecasts of real GDP growth generated by the base case version of the model have a RMSE of 1.95 per cent, which is similar to the results obtained by Babineau and Braun (2002) using various univariate models.

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[17] This value also corresponds to the average performance of private sector forecasts of real GDP growth in industrialized countries as a group. Juhn and Loungani (2002) examine mean private sector forecasts of real GDP growth in several industrialized countries published in *Consensus Forecasts* by Consensus Economics. The *Consensus Forecasts* have a RMSE of 1.47 and 1.62 per cent for the 11- and 13-month horizons, respectively.

Inflation

The amount of forecast uncertainty surrounding inflation in the model was calibrated using a great deal of judgment. This reflects the fact that the monetary policy rule in the model is specified with reference to an explicit inflation target, which is counterfactual to most of the Canadian historical experience.[18] The emergence of a low and stable inflation environment in the early 1990s has had a major influence on the amount of uncertainty surrounding inflation forecasts. This is captured by the simulation experiments conducted in this paper. The monetary policy rule in the model is specified to depict a credible inflation targeting regime, wherein the monetary authority seeks to keep core CPI inflation within a two-percentage point target band most of the time. This is implemented using a forward-looking reaction function:

$$(1) \qquad (r_t - r_t^*) = \gamma_1(E_t\pi_{t+1} - \pi^*) + \gamma_2(r_{t-1} - r_{t-1}^*)$$

where $(r_t - r_t^*)$ represents the deviation of the short-term real interest rate from its equilibrium level and $(E_t\pi_{t+1} - \pi^*)$ represents the projected deviation of core CPI inflation from the mid-point of the target range over the coming quarter.

The parameter γ_1 captures the responsiveness of monetary policy to inflationary pressure projected over the coming quarter.[19] Higher values of γ_1 imply that the monetary authority responds more aggressively, resulting in a higher degree of inflation control. Core CPI inflation generated by in the base case calibration of the model exhibits a standard deviation of one per cent, which implies that it fluctuates within a two percentage point range about 70 per cent of the time. This entails higher volatility than Canada's experience with inflation targeting since the end of 1995,[20] but much less volatility relative to previous

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[18] The *Inflation Reduction Guidelines*, announced in February 1991, specified a gradual reduction in inflation from the end of 1992 to the end of 1995. This was followed by a 1% to 3% target range, announced in February 1993, to be attained by the end of 1995. The target range has been extended to the end of 2006.

[19] The one-quarter-ahead time horizon used to specify the monetary policy rule was chosen on the basis of minimizing the output-inflation variance trade-off in the model. The results presented in this paper are robust with respect to alternative formulations of the monetary policy rule, however.

[20] Between December 1995 and May 2002, the annual percentage change in the total CPI and the core CPI have been within the two-percentage point target range 98 and 83 per cent of the time, respectively.

decades.[21] Forecasts of core CPI inflation generated using the low and high calibrations have a RMSE of 0.26 to 0.44 per cent, respectively, which imply that core CPI inflation would be within a two percentage-point target range 85 and 57 per cent of the time, respectively. We consider the implications of having a higher amount of uncertainty surrounding inflation forecasts later in the paper.

Interest rates

As mentioned above, the monetary authority in the model seeks to keep inflation within the target range by adjusting its instrument–the nominal short-term interest rate–to curtail impending inflationary pressures.[22] The autoregressive term ($r_{t-1} - r_{t-1}^*$) in the reaction function captures the "interest-rate smoothing" aspect of setting monetary policy. High (positive) values of the parameter γ_2 act to dampen quarterly movements in short-term interest rates, which delays the monetary policy response.[23] The parameter γ_2 is set to a value of 0.8, which is consistent with estimates obtained by Orphanides and Wieland (1998) for the U.S.

One-year ahead forecasts of the nominal short-term interest rate generated by the base case calibration have a RMSE of 0.93 per cent. This is very similar to the RMSE of the mean SPF forecasts for Canada and the US (0.85 and 0.90 per cent, respectively). The RMSE of one-year ahead forecasts of the nominal long-term interest rate have a RMSE of 0.52 per cent, which is consistent with the RMSE of the mean SPF forecasts for Canada (0.51 per cent over the period 1990-2000), but lower than that for the US (0.85 per cent over the period 1982-2000).

The Budget Balance and Net Debt

Forecasts of the budget balance generated in the base case calibration have a RMSE of 0.5 per cent of GDP (which is about $5.6 billion in 2001). This is somewhat higher than recent

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[21] Core CPI inflation has a standard deviation of 2.76 per cent over the period 1973-1992.

[22] Although the reaction function is specified with reference to the real interest rate, the equation can be rewritten in terms of the nominal interest rate simply by substituting the identity $i_t = r_t - \pi^e_{t-1}$.

[23] For a more detailed discussion of how the specification of the monetary policy rule influences fiscal planning objectives see Hostland (2001b).

experience in Canada,[24] but low relative to the forecasts made by the Congressional Budget Office for the US.[25] The low and high calibrations imply a RMSE in the 0.40 to 0.66 per cent range. Forecasts of net federal debt generated in the base case calibration have a RMSE of 0.92 per cent of GDP (about $10 billion in 2001), with a range of 0.74 to 1.11 percentage points (about $8 to $12 billion in 2001).

3.2 The Medium-Term Fiscal Planning Problem

The fiscal authority in our analysis seeks to keep the debt-to-GDP ratio on a downward profile over time by planning to run a budget surplus in each coming fiscal year. The base case scenario entails planning a budget balance of $4 billion each year, which would result in a total of $40 billion in debt repayment over a ten-year planning horizon. This would imply a 20 percentage point reduction in the federal net debt-to-GDP ratio.[26] In preparing the fiscal plan for each coming year, the fiscal authority makes discretionary changes to taxes and/or program spending in response to unanticipated economic and fiscal developments. For example, if economic conditions turn out to be weaker than anticipated, the projected budget balance for the coming year would be less than $4 billion. The fiscal authority would then have to raise taxes and/or cut expenditures planned over the coming year in order to raise the projected surplus to the $4 billion level.

The need to make discretionary changes conflicts with the desire to make multi-period commitments to program spending and tax measures. This aspect of fiscal planning is incorporating into our analysis following the approach taken by Georges and Moreau (2002a). They consider a fiscal planning framework that includes both discretionary and non-

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[24] Private sector forecasts of the federal budget balance in Canada have a RMSE of 0.3 over the period 1994-2000.

[25] Kliesen and Thorton (2001) examine forecasts of the US federal budget balance made by the Congressional Budget Office (CBO). They report a RMSE of 1.3 per cent at a one-year forecasting horizon over the period 1976-1999. Their analysis indicates, however, that a large proportion of the forecast errors can be attributed to "legislative" and "technical" factors in addition to uncertainty associated with economic projections.

[26] Nominal GDP grows at an average rate of 4.5 per cent over the ten-year planning period. This reflects an average inflation rate of 2.0 per cent (consistent with the mid-point of the target range) and an average rate of potential output growth of 2.5 per cent.

discretionary fiscal measures. The initial fiscal plan includes a commitment to provide a minimum level of program spending over the ten-year planning period. The commitment is irreversible in the sense that program spending cannot be reduced below the guaranteed minimum level nor can tax rates be increased, regardless of economic conditions. This represents the non-discretionary component of fiscal measures. Multi-period commitments to tax and spending measures limit the amount of discretionary measures that are available in the future. We consider a scenario where discretionary measures are limited to between five to ten per cent of program spending over the ten-year planning horizon.[27] This means that discretionary spending can be reduced by a maximum of five per cent in the first year, increasing to ten per cent in the tenth year, with tax rates unchanged. The amount of discretionary measures available increases over the planning horizon along with the amount of uncertainty surrounding the fiscal plan.

The fiscal authority in the model enhances its multi-period commitments to tax and spending measures in response to permanent increases in nominal output, keeping the amount of discretionary measures available constant over the remainder of the planning horizon. For example, when nominal output growth turns out to be higher than projected, there is additional fiscal room available over the remainder of the planning horizon. The additional fiscal room can be used to enhance multi-period commitments to tax and spending measures, without changing the amount of discretionary measures available over the remainder of planning horizon. This ensures that the fiscal plan is revised over time to take into account unanticipated economic developments without raising the risk of a deficit outcome.

3.3 Stochastic Simulation Results

The stochastic simulation procedure operates as follows. The initial fiscal plan is set to generate $4 billion budget surplus in each year of the ten-year planning horizon, implying a total of $40 billion in debt repayment. Stochastic shocks displace all the endogenous variables

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[27] The amount of discretionary spending implied by this scenario is used for illustrative purposes only and does not represent actual tax and spending commitments of the federal government.

in the model each quarter. The monetary authority in the model responds to shocks each quarter whereas, the fiscal authority revises the fiscal plan only once every four quarters. This reflects the fact that monetary policy operates on an-ongoing basis whereas major changes to the fiscal plan are typically made in the context of an annual budget process.[28] The stochastic simulation process is repeated 1250 times to generate numerical approximations for the distributions of simulated variables, which are used to calculate the dispersion of outcomes.

We report simulation results generated with and without limits on discretionary measures in order to demonstrate the importance of having multi-period commitments to tax and spending measures. In the case where there is an unlimited amount of discretionary measures available, the model, stochastic shocks and policy rules are all symmetric and hence, simulated variables are centred on their respective equilibrium values. Net federal debt therefore declines by $4 billion each year on average, as planned, resulting in a total of $40 billion in debt repayment over the ten-year planning horizon. This is represented by bottom line in Figure 1 labelled "planned debt reduction". We measure the dispersion of outcomes by calculating the 95 per cent confidence level for net federal debt. This can be interpreted as a "ceiling" on debt reduction in a probabilistic sense – it represents the minimum amount of debt reduction to be attained with 95 per cent probability. In other words, there would only be a five per cent risk that net federal debt would increase above the ceiling. The solid line in Figure 1 represents the "debt ceiling" (the 95 per cent confidence level for net federal debt) generated in the base case simulation experiment.

A different picture emerges when there is a limited amount of discretionary measures available. This is illustrated in Figure 2, which shows that the average debt reduction outcome is above the planned debt reduction profile. The intuition is as follows. When economic conditions turn out to be substantially weaker than anticipated, the fiscal authority is unable to make the discretionary changes required to set aside $4 billion in fiscal prudence without backtracking on its commitment to provide a minimum level of tax and spending measures. In

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[28] Since December 2000, the Bank of Canada announces changes to the Bank Rate at eight scheduled dates (fixed action dates) each year.

these situations, the level of fiscal prudence in the fiscal plan falls below $4 billion. In the base case simulation experiment a limit of discretionary measures, the average level of fiscal prudence is only $3.4 billion, $0.6 billion short of the desired $4 billion level. The shortfall in fiscal prudence results in a total of $34 billion of debt repayment over the ten-year planning horizon, $6 billion short of the $40 billion objective.

The limit on discretionary spending also has implications for the debt ceiling. This can be seen by comparing the debt ceilings generated by the base case simulations shown in Figures 1 and 2. When there are unlimited discretionary measures, the debt ceiling declines by a total of $14.5 billion over the ten-year planning horizon (shown in Figure 1). When discretionary measures are limited, the debt ceiling increases by $7.4 billion over the ten-year planning horizon (shown in Figure 2). The difference is due to the same explanation give above. Multi-year commitments to tax and spending measures constrain the ability of the fiscal authority to set aside $4 billion in fiscal prudence when economic conditions turn out to be weaker than projected. The constraint results in a wider dispersion of debt reduction outcomes, which implies a higher debt ceiling.

Varying the amount of uncertainty

We now examine how varying the amount of uncertainty surrounding economic projections influences debt reduction outcomes. Simulation experiments are conducted using the "low" and "high" calibrations of the model reported in Table 5. A higher amount of uncertainty leads to larger fluctuations in the budget balance, resulting in a wider range of outcomes for debt reduction. This is illustrated in Figures 1 and 2. Figure 1 represents the case where there are unlimited discretionary measures. In this case, all simulated variables are centred on their respective equilibrium values and hence, net federal debt declines by $4 billion each year on average, as planned, regardless of the amount of uncertainty. Varying the amount of uncertainty does affect the dispersion of outcomes, however. The debt ceiling declines by a total of $21.4 billion over the ten-year planning period in the simulations conducted with the low calibration, but only $7.2 billion in simulations conducted with the high calibration. In

other words, increasing the amount of uncertainty over the "low" to "high" range raises the debt ceiling by a total of $14.2 billion over the ten-year planning horizon.

Figure 2 shows the extent to which varying the amount of uncertainty affects the average debt reduction outcome and the debt ceiling in the case where discretionary measures are limited. Increasing the amount of uncertainty over the low to high range raises the average debt reduction outcome by a total of $5.1 billion and raises the debt ceiling by a total of $27.8 billion over the ten-year planning horizon. Comparing the results illustrated in Figures 1 and 2, one can see that varying the amount of uncertainty has a much more prominent influence on debt reduction outcomes when there are limited discretionary measures.

Here is an alternative way to view these results. Suppose that the debt reduction objective was to ensure that net debt did not increase over the planning period with 95 per cent confidence. This could be implemented by setting fiscal prudence at a level that would keep the debt ceiling constant over the planning period. Simulation results obtained using the low calibration indicate that reducing the level of fiscal prudence by $0.5 billion would attain this objective. Under the high calibration simulation, the level of fiscal prudence would have to be increased to $2.3 billion. In other words, varying the amount of uncertainty over this range changes the level of fiscal prudence by $2.8 billion.

Varying the amount of uncertainty surrounding forecasts of inflation

The analysis above examined the implications of varying the overall amount of uncertainty surrounding economic projections. We now focus on uncertainty surrounding forecasts of inflation. Recall that the base case calibration outlined above was designed to match the low and stable inflation environment that emerged in the early 1990s. We now consider how higher uncertainty surrounding inflation forecasts would influence fiscal planning objectives. This entails simulating the model with the alternative calibration settings reported in Table 6. The first column, labelled "low" uncertainty, corresponds to the base case calibration examined above, where core CPI inflation is kept within the two percentage-point target range 70 per cent of the time. The other two calibrations entail more volatility in inflation and hence, higher uncertainty surrounding inflation forecasts. In the "medium" and "high"

calibrations, core CPI inflation is kept within a two percentage-point range 60 and 50 per cent of the time, respectively.

Simulation results generated using the alternative calibrations of the model indicate that varying the amount of uncertainty surrounding inflation forecasts has only minor implications for debt reduction outcomes when there are unlimited discretionary measures. The implications are quite important, however, when discretionary measures are limited. This is illustrated in Figure 3. Increasing the amount of uncertainty surrounding inflation forecasts from the low to the medium calibration increases the average debt reduction outcome by a total of $1.5 billion over the ten-year planning horizon, while the debt ceiling increases by $8.7 billion. With the high calibration, the average debt reduction outcome increases by an additional $8.7 billion over the ten-year planning horizon, while the debt ceiling increases by $39.6 billion.

These simulation experiments demonstrate the benefits of stable inflation for fiscal planning. Note in particular the non-linear nature of the relationship between the probability of keeping inflation within a two percentage point range and debt reduction outcomes. Figure 3 shows that reducing the probability from 70 to 60 per cent (implied by the low versus medium calibration) has relatively minor implications for average debt reduction outcomes and the debt ceiling, whereas reducing the probability further to 50 per cent (implied by the high calibration) has major implications.

Persistent forecast errors

The analysis to this point has focused on the dispersion of forecast errors (as measured by the RMSE). We now turn to consider the implications of forecasting errors that exhibit persistence. This is captured by inducing autocorrelation in the forecast errors generated by the model.

In order to interpret the results, it is important to make a distinction between the variance of the forecast errors and the degree of autocorrelation. Consider a forecast error $\hat{e}$ that follows a 1st-order moving-average process given by:

$$\hat{e}_t = u_t + \theta u_{t-1}$$

where $u_t \sim (0, \sigma^2)$ is a random error term. Higher values of θ imply a higher forecast error variance: $Var(\hat{e}_t) = (1+\theta^2)\sigma^2$. Introducing autocorrelated forecast errors into our analysis therefore raises the amount of uncertainty surrounding the fiscal plan. One can control for this by reducing the variance of the random error term σ to keep forecast error variance $Var(\hat{e}_t)$ unchanged. The model was calibrated for a range of values for θ and σ, keeping the forecast error variance $Var(\hat{e}_t) = (1+\theta^2)\sigma^2$ constant. In other words, a higher degree of autocorrelation in the forecast errors (determined by θ) was offset by lower variance for the random error term (determined by σ). The stochastic simulation results obtained using values of θ in the 0 to 0.75 range were found to be very similar. This indicates that persistence in forecast errors affects fiscal planning objectives only to the extent that it increases the variance of forecast error. In other words, the fiscal authority has an incentive to avoid persistent forecast errors because they contribute to the amount of uncertainty surrounding the fiscal plan.

Biased forecasts

We also examine the implications of using biased forecasts. We consider the cases where estimates of potential output growth are biased by half of a percentage point. The magnitude of the bias (half of a percentage point) is similar to mean forecast errors made by the private sector forecasters over various sub-periods reported in Table 4.[29] Two sets of simulations were conducted: one with an under-estimate of potential output growth; the other with an over-estimate. Over-estimating potential output growth results in budget balance outcomes that are less than the projected $4 billion level on average, which means less debt reduction than planned. The effect is empirically small, however, when there are unlimited discretionary measures. The average debt reduction outcome and debt ceiling are less than $1 billion higher over the ten-year planning period. A similar result, in the opposite direction, occurs when potential output growth is under-estimated.

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[29] The mean SPF forecasts in Canada have a mean error of 0.64 per cent over the 13-year period 1975-1987. Similarly, the mean SPF and Livingston forecasts in the US have mean errors of 0.64 and 0.55 per cent, respectively, over the 16-year period 1985-2000.

A much difference picture emergences when discretionary measures are limited. The simulation results are illustrated in Figure 4. The thick solid lines represent the results generated using the base case calibration generated with unbiased estimates. The dotted lines illustrate the implications of over- and under-estimating potential output growth.

Under-predicting potential output growth results in higher debt reduction outcomes on average, along with a lower debt ceiling. The intuition is as follows. Under-estimating potential output growth implies under-estimating the amount of fiscal room available in the future, which increases the scope for making discretionary changes. As a consequence, the fiscal authority foregoes enhancing multi-period commitments when there is fiscal room available. The "floor constraint" on program spending is therefore binding less often. The average level of fiscal prudence is $3.6 billion, which is above the average level of $3.3 billion attained with unbiased forecasts. This reduces the probability of a deficit outcome, and results in a more debt reduction on average. Under-predicting potential output growth by half of a percentage point reduces the average debt reduction outcome by a total of $2.7 billion and reduces the debt ceiling by $5 billion over the ten-year planning horizon.

Figure 4 shows that over-predicting potential output growth has much more serious consequences. Over-predicting potential output growth by half of a percentage point raises the average debt reduction outcome by a total of $12.5 billion and raises the debt ceiling by $47.6 billion over the ten-year planning horizon. The intuition is along the same lines outlined above. Over- predicting potential output growth implies over-estimating the amount of fiscal room available in the future, which decreases the scope for making discretionary changes. As a consequence, the fiscal authority enhances multi-period commitments when there is no fiscal room available. The "floor constraint" on program spending is therefore binding more often. The average level of fiscal prudence is only $2.0 billion, which is considerably below the average level of $3.3 billion attained with unbiased forecasts. This raises the probability of a deficit outcome, and results in a less debt reduction on average.

Similar results in obtained with biased forecasts of inflation. The asymmetry is due to the irreversible nature of the constraint on discretionary spending. The constraint is only

binding when economic conditions turn out to be weaker than anticipated. The constraint is binding more often when output growth and/or inflation are over-estimated. Under-predicting output growth and/or inflation means that the constraint is binding less often, which leaves open the option of enhancing multi-period commitments in the future.

4. Conclusions

Our analysis indicates that the amount of uncertainty surrounding forecasts of output growth, inflation and interest rates has declined over time in Canada and the US. Since the mid-1980s, there has been a marked improvement in the performance of mean forecasts obtained from private sector forecasters, as well as simple autoregressive forecasts. The reduction in the amount of uncertainty surrounding economic forecasts is found to have important implications for fiscal planning when discretionary spending is limited. This has relatively minor implications for average debt reduction outcomes, but major implications for the dispersion of outcomes. Obtaining accurate measures of the amount of uncertainty surrounding the fiscal plan therefore is not very important for average debt reduction outcomes, but is very important for determining a debt ceiling.

The stochastic simulation experiments presented in the paper demonstrate the benefits of stable inflation for fiscal planning. The simulation results indicate that keeping core CPI inflation within a two-percentage point range 50 versus 70 per cent of the time would lead to a substantial increase in the debt ceiling. The stochastic simulation experiments also illustrate the asymmetric nature of the fiscal planning problem associated with making multi-period commitments to tax and spending measures. The simulation results demonstrate that under-estimating output growth and/or inflation by half of a percentage point would have relatively minor implications for debt reduction outcomes, whereas over-predicting output growth and/or inflation by the same amount would have major implications.

On a final note, we wish to draw attention to an important caveat relating to the simplistic nature of the fiscal planning process depicted in this paper. The fiscal authority in our stochastic simulation framework sets aside $4 billion in fiscal prudence regardless of fiscal developments. A more sophisticated fiscal planning strategy could entail adjusting the level of

fiscal prudence in accordance with debt reduction outcomes and current economic conditions. Moreover, the fiscal authority could also take into account some of the different dimensions of uncertainty considered in the paper. For example, because that it is difficult to provide accurate estimates of the amount of uncertainty surrounding the fiscal plan, a prudent strategy might be to plan for the worst within the range of likely outcomes. This could entail initially designing the fiscal plan with reference to a "high calibration" setting along with a low estimate for potential output growth. This would help ensure that level of debt declines early on in the planning period. A less prudent approach could then be adopted over time as the debt-to-GDP period approaches its steady-state level. We leave extensions of our analysis along these lines for future research.

Table 1a: Standard deviation of output growth, inflation and interest rates in Canada

Sub-periods: 1961-1972 versus 1973-1992

	1953-1972	1973-1992	Difference
Nominal GDP	3.65	5.05	1.40
Real GDP	2.71	2.87	0.16
GDP deflator	1.70	3.80	2.10
Core CPI	1.51	2.75	1.24
Short-term interest rates	1.54	2.89	1.35
Long-term interest rates	1.43	2.08	0.65

Sub-periods: 1973-1992 versus 1993-2000

	1973-1992	1993-2000	Difference
Nominal GDP	5.05	2.04	-3.01
Real GDP	2.87	1.40	-1.47
GDP deflator	3.8	1.44	-2.36
Core CPI	2.75	0.30	-2.45
Short-term interest rates	2.89	1.12	-1.77
Long-term interest rates	2.08	1.28	-0.80

Sub-periods: 1973-1986 versus 1987-2000

	1973-1986	1987-2000	Difference
Nominal GDP	4.33	2.94	-1.39
Real GDP	2.90	2.19	-0.71
GDP deflator	3.68	1.63	-2.05
Core CPI	2.59	1.20	-1.39
Short-term interest rates	3.17	2.93	-0.23
Long-term interest rates	2.39	1.73	-0.66

Table 1b: Standard deviation of output growth, inflation and interest rates in the US

Sub-periods: 1961-1972 versus 1973-1992

	1953-1972	1973-1992	Difference
Nominal GDP	2.84	2.91	0.07
Real GDP	2.47	2.58	0.11
GDP deflator	1.51	2.59	1.08
Core CPI	1.84	2.75	0.91
Short-term interest rates	1.52	2.57	1.05
Long-term interest rates	1.21	2.05	0.84

Sub-periods: 1973-1992 versus 1993-2000

	1973-1992	1993-2000	Difference
Nominal GDP	2.91	0.68	-2.23
Real GDP	2.58	0.98	-1.60
GDP deflator	2.59	0.44	-2.15
Core CPI	2.75	0.38	-2.37
Short-term interest rates	2.57	0.89	-1.68
Long-term interest rates	2.05	0.57	-1.48

Sub-periods: 1973-1986 versus 1987-2000

	1973-1986	1987-2000	Difference
Nominal GDP	2.81	1.09	-1.71
Real GDP	2.94	1.36	-1.58
GDP deflator	2.60	0.89	-1.72
Core CPI	2.94	1.06	-1.88
Short-term interest rates	2.66	1.47	-1.19
Long-term interest rates	2.24	1.00	-1.24

Table 2a: RMSE of Forecasts Generated by AR1 model for Canada

Sub-periods: 1961-1972 versus 1973-1992

	1961-1972	1973-1992	Difference
Nominal GDP	2.74	4.24	1.50
Real GDP	2.78	3.19	0.41
GDP deflator	1.44	3.10	1.66
Core CPI	1.95	2.66	0.71
Short-term interest rates	1.20	2.75	1.55
Long-term interest rates	0.53	1.45	0.92

Sub-periods: 1973-1992 versus 1993-2000

	1973-1992	1993-2000	Difference
Nominal GDP	4.24	2.55	-1.69
Real GDP	3.19	1.32	-1.87
GDP deflator	3.1	1.82	-1.28
Core CPI	2.66	0.65	-2.01
Short-term interest rates	2.75	1.46	-1.29
Long-term interest rates	1.45	0.81	-0.64

Sub-periods: 1973-1986 versus 1987-2000

	1973-1986	1987-2000	Difference
Nominal GDP	4.31	3.29	-1.02
Real GDP	3.08	2.46	-0.62
GDP deflator	3.62	1.61	-2.01
Core CPI	3.13	0.73	-2.40
Short-term interest rates	2.95	1.82	-1.13
Long-term interest rates	1.66	0.79	-0.87

Table 2b: RMSE of Forecasts Generated by AR1 model for the US

Sub-periods: 1961-1972 versus 1973-1992

	1961-1972	1973-1992	Difference
Nominal GDP	2.87	2.75	-0.12
Real GDP	2.58	2.64	0.06
GDP deflator	1.00	1.83	0.83
Core CPI	1.49	2.50	1.01
Short-term interest rates	1.05	1.98	0.93
Long-term interest rates	0.48	1.34	0.86

Sub-periods: 1973-1992 versus 1993-2000

	1973-1992	1993-2000	Difference
Nominal GDP	2.75	1.28	-1.47
Real GDP	2.64	0.98	-1.66
GDP deflator	1.83	0.51	-1.32
Core CPI	2.5	0.54	-1.96
Short-term interest rates	1.98	0.74	-1.24
Long-term interest rates	1.34	0.74	-0.60

Sub-periods: 1973-1986 versus 1987-2000

	1973-1986	1987-2000	Difference
Nominal GDP	3.12	1.41	-1.71
Real GDP	2.97	1.30	-1.67
GDP deflator	2.14	0.60	-1.54
Core CPI	2.96	0.60	-2.36
Short-term interest rates	2.17	1.09	-1.08
Long-term interest rates	1.57	0.66	-0.91

Table 3: RMSE of Private Sector Forecasts over One-Year Horizon

	Forecasts of Real GDP Growth			
	1975-2000	1975-1987	1988-2000	Difference[1]
Canada - SPF	1.52	1.70	1.31	0.39
	1969-2000	1969-1984	1985-2000	
US - SPF	1.60	1.84	1.30	0.54
	1972-2000	1972-1984	1985-2000	
US - Livingston	1.87	2.40	1.73	0.67
	Forecasts of GDP Deflator Inflation			
	1976-1998	1976-1987	1988-1998	Difference[1]
Canada - SPF	2.31	2.97	1.45	1.52
	1969-2000	1969-1986	1987-2000	
US - SPF	1.62	2.07	0.70	1.37
	1972-2000	1972-1984	1985-2000	
US - Livingston	2.11	2.89	0.70	2.19
	Forecasts of Total CPI Inflation			
	1976-2000	1976-1987	1988-2000	Difference[1]
Canada - SPF	2.06	2.77	1.02	1.75
	1974-2000	1974-1987	1988-2000	
US - Livingston	1.52	1.99	0.88	1.11
	Forecasts of Short-term Interest Rates			
	1982-2000	1982-1991	1992-2000	Difference[1]
US - SPF	0.90	1.05	0.70	0.35
	Forecasts of Long-term Interest Rates			
	1982-2000	1982-1991	1992-2000	
US - SPF	0.85	0.94	0.85	0.09

Note:

1. "Difference" between RMSE calculated over sub-periods.

Table 4: Mean Error of Private Sector Forecasts over One-Year Horizon

Forecasts of Real GDP Growth			
	1975-2000	1975-1987	1988-2000
Canada - SPF	0.35	0.64	0.05
	1969-2000	1969-1984	1985-2000
US - SPF	-0.07	-0.79	0.64
	1972-2000	1972-1984	1985-2000
US - Livingston	-0.14	-1.07	0.55
Forecasts of GDP Deflator Inflation			
	1976-1998	1976-1987	1988-1998
Canada - SPF	-0.96	-1.31	-0.63
	1969-2000	1969-1986	1987-2000
US - SPF	0.31	0.85	-0.38
	1972-2000	1972-1984	1985-2000
US - Livingston	0.45	1.04	-0.15
Forecasts of Total CPI Inflation			
	1976-2000	1976-1987	1988-2000
Canada - SPF	-0.51	-0.77	-0.27
	1974-2000	1974-1987	1988-2000
US - Livingston	-0.02	0.16	-0.18
Forecasts of Short-term Interest Rates			
	1982-2000	1982-1991	1992-2000
US - SPF	-0.16	-0.23	-0.08
Forecasts of Long-term Interest Rates			
	1982-2000	1982-1991	1992-2000
US - SPF	-0.001	0.005	-0.006

Table 5: Calibration of the Stochastic Simulation Model

RMSE of forecasts generated by the model

One-year-ahead horizon

	Calibration		
Variable	*Low*	*Base case*	*High*
GDP growth	1.32	1.51	1.74
Core CPI inflation	0.26	0.35	0.44
Short-term interest rate	0.68	0.93	1.19
Long-term interest rate	0.50	0.52	0.55
Budget balance / GDP	0.40	0.52	0.66
Net debt / GDP	0.74	0.92	1.11

Five-year-ahead horizon

	Calibration		
Variable	*Low*	*Base case*	*High*
GDP growth	1.63	1.94	2.29
Core CPI inflation	0.56	0.77	0.98
Short-term interest rate	1.04	1.43	1.83
Long-term interest rate	0.52	0.57	0.62
Budget balance / GDP	0.40	0.53	0.67
Net debt / GDP	1.34	1.60	1.93

Table 6: Calibration of the Stochastic Simulation Model

With Different Amounts of Uncertainty Surrounding Inflation Forecasts

RMSE of forecasts generated by the model

One-year-ahead horizon

	Uncertainty Surrounding Inflation Forecasts		
Variable	*Low (base case)*	*Medium*	*High*
GDP growth	1.51	1.51	1.53
Core CPI inflation	0.35	0.50	0.97
Short-term interest rate	0.93	0.99	1.26
Long-term interest rate	0.42	0.44	0.51
Budget balance / GDP	0.92	0.94	1.04
Net debt / GDP	0.52	0.54	0.64

Five-year-ahead horizon

	Uncertainty Surrounding Inflation Forecasts		
Variable	*Low (base case)*	*Medium*	*High*
GDP growth	1.94	1.95	1.97
Core CPI inflation	0.77	0.88	1.31
Short-term interest rate	1.43	1.48	1.69
Long-term interest rate	0.47	0.48	0.55
Budget balance / GDP	1.60	1.68	2.07
Net debt / GDP	0.53	0.55	0.67

Figure 1: Debt Reduction with Unlimited Discretionary Spending

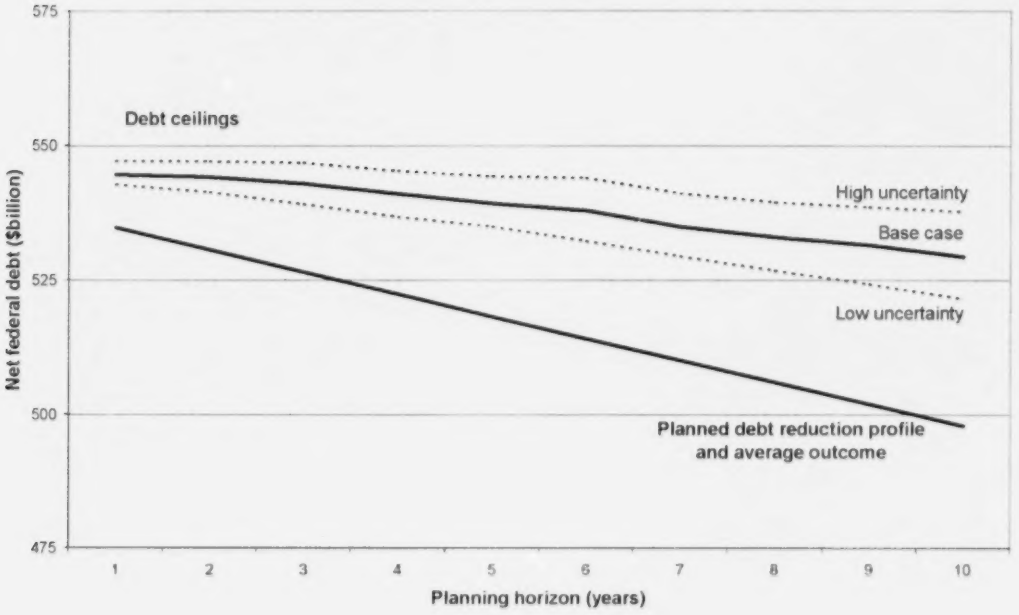


Figure 2: Debt reduction with limited discretionary spending

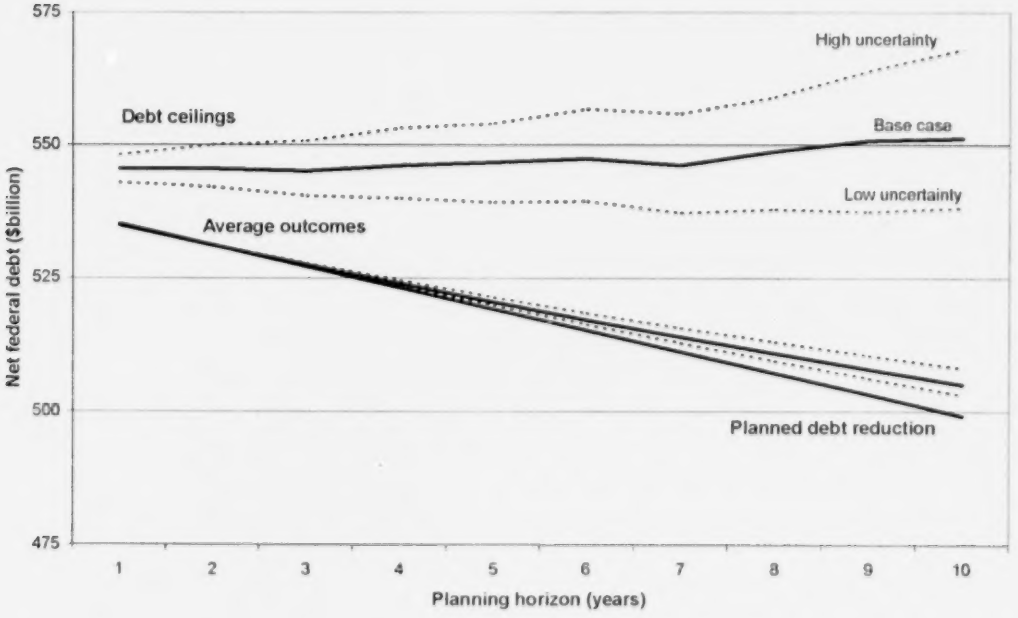


Figure 3: Debt Reduction with Higher Uncertainty Surrounding Inflation Forecasts

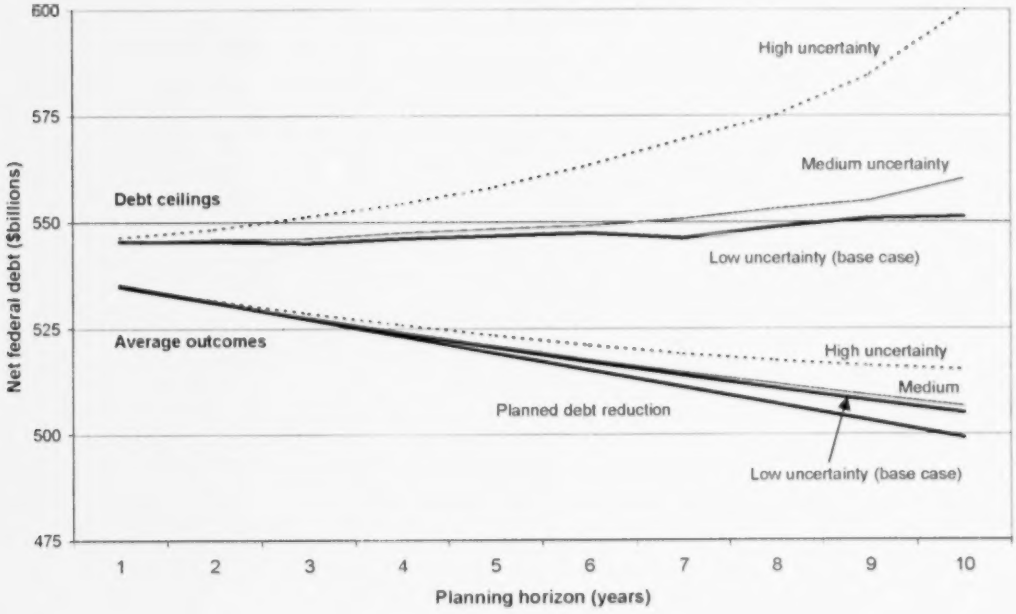
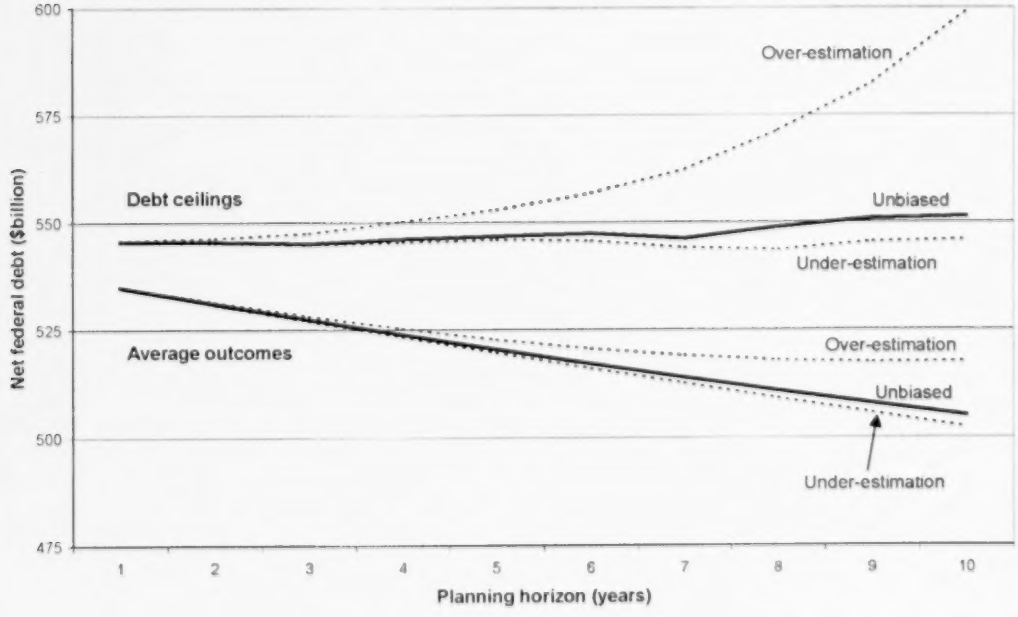


Figure 4: Debt reduction with biased forecasts of potential output growth



Appendix 1: Description of the Data

Output Growth, Inflation and Interest Rates

Canada

Nominal GDP – Annual growth rate of:

GDP at current prices: 1961Q1 – 2001Q4 (Cansim series: v498086)

Real GDP – Annual growth rate of:

GDP at constant 1997 prices: 1961Q1 – 2001Q4 (Cansim series: v1992259)

GDP price deflator = Nominal GDP growth - Real GDP growth

Total CPI – Annual growth rate of:

CPI All-items (Index, 1992=100) January 1914- December 2001 (Cansim series: v735319)

Core CPI – Annual growth rate of:

CPI excluding food, energy and the effect of indirect taxes (Index, 1992=100) January 1984 - December 2001 (Cansim series: v36395)

CPI excluding food and energy (Index, 1992=100) January 1961- December 1984 (Cansim series: v735600)

Short-term interest rate:

Average yield on 3-month Government of Canada treasury bills January 1934 – December 2001 (Cansim series: v122541)

Long-term interest rate:

Government of Canada benchmark bond yield 10 years June 1982 – December 2001 (Cansim series: v122543)

United States[30]

Nominal GDP – Annual growth rate of:

GDP at current prices: 1947Q1 – 2001Q4

Real GDP – Annual growth rate of:

GDP chained 1996 dollars: 1947Q1 – 2001Q4

GDP Price Deflator – Annual growth rate of:

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[30] All US data were obtained from the Federal Reserve Bank of St. Louis on-line data base: www.stls.frb.org/fred/index.html .

GDP Chain-type Price Index: 1947Q1 – 2001Q4

Total CPI – Annual growth rate of:

CPI all-items (Index, 1982-84=100) January 1947- December 2001

Core CPI – Annual growth rate of:

CPI all-items less food and energy (Index, 1982-84=100) January 1947- December 2001

Short-term interest rate:

Average yield on 3-Month US Treasury Bill Rate, Secondary Market January 1934 – December 2001

Long-term interest rate:

Average yield on 10-Year US Treasury Constant Maturity Rate, April 1957 – December 2001

Private Sector Forecasts

Canada

The Conference Board Survey of Forecasters

Since 1975 the *Conference Board of Canada* has conducted a survey (*Survey of Forecasters*) of between 13 and 67 private sector forecasters in Canada (consisting mainly of private forecasting firms, investment firms and the major chartered banks). The survey is conducted each quarter, about a month after the release of the National Accounts. The survey requests forecasts of several macroeconomic variables, including growth rates of real GDP, the GDP price deflator and the CPI, in the current and forthcoming calendar year.[31] The survey was expanded in 1990 to include forecasts of interest rates.

We used the mean of survey responses collected in the first quarter (late March) of each year for forecasts of real GDP growth and GDP deflator inflation. This roughly corresponds to a one-year forecast horizon (since the forecasts were made using National Accounts data for the fourth quarter of the previous year). In the case of the CPI, we used the mean of survey responses collected in the fourth quarter (late December) of the previous year so the forecast horizon is roughly 13 months (since the forecasts were made using CPI data for November).

United States

The Livingston Survey

The Livingston Survey was initiated in 1946 by a business journalist, Joseph Livingston. The survey is conducted twice a year, in June and December. The initial survey questionnaire requested forecasts of the CPI, the Producer Price Index (PPI) and nominal GNP over the coming 6 and 12 months from a group of "prominent economists" in the United States.[32] Coverage has grown considerably over time, from just a "handful" of economists in 1946 to over 50 respondents in the most recent survey with diverse backgrounds. The survey questionnaire was expanded in 1971 to include forecasts on several additional variables, including real GDP growth and the GDP price deflator (GNP prior to 1992) and again in 1992 to include interest rate forecasts. It was taken over by the Federal Reserve Bank of Philadelphia in 1990.[33]

We used the mean forecast obtained from the December survey for CPI inflation over the coming year. The forecast horizon is between 13 and 14 months depending on whether the November release of the CPI was available when the forecasts were made.

The Survey of Professional Forecasters

The American Statistical Association (ASA) and the National Bureau of Economic Research (NBER) initiated a quarterly survey in 1968, which included questions on the growth rates of nominal and real GDP (GNP prior to 1992) over the forthcoming year. The survey was expanded in 1981 to include forecasts of CPI inflation and interest rates. The ASA/NBER survey originally attracted much interest, as about 50 forecasters were included in the late 1960s. However, by the late 1980s the number of respondents declined to fewer than 20. The

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[31] Forecasts of the GDP deflator were eliminated from the survey in 1998.

[32] The original survey requested forecasts of the level of the CPI. This complicated the evaluation of inflation forecasts since one must infer initial levels used by survey respondents in generating their price level forecasts. This problem was corrected in 1992 when the survey was revised to request forecasts of CPI growth rates. See Carlson (1977) for a detailed discussion of measurement issues surrounding the Livingston survey.

[33] The Livingston Survey data are available at: www.phil.frb.org/files/liv/datai.html .

ASA and the NBER discontinued the survey in 1990, when it was taken over by the Federal Reserve Bank of Philadelphia.[34] The number of participants has increased to over 30, comprised solely of professional forecasters employed in the financial sector (investment firms and banks), economic consulting firms, university research centers and other private firms.[35]

We used survey responses collected in the first quarter of each year for forecasts of real GDP growth and GDP deflator inflation. This roughly corresponds to a one-year forecast horizon (since the forecasts were made using National Accounts data for the fourth quarter of the previous year).

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[34] The Survey of Professional Forecasters data are available at: www.phil.frb.org/econ/spf/index.html .

[35] For further information about the Survey of Professional Forecasters, see Croushore (1993).

Appendix 2: Estimates of Autoregressive Model

Estimates of AR1 model: $y_t = \alpha + \beta y_{t-1} + \varepsilon_t$

Over sample period: 1953-2000

Canada

	β	p-value[1]	SER[2]	R^2
Nominal GDP	0.50	0.00	3.75	0.26
Real GDP	0.05	0.74	2.67	0.00
GDP deflator	0.80	0.00	1.98	0.66
Core CPI	0.84	0.00	1.41	0.74
Short-term interest rates	0.84	0.00	1.85	0.74
Long-term interest rates	0.93	0.00	0.96	0.90

United States

	β	p-value	SER	R^2
Nominal GDP	0.45	0.00	2.55	0.20
Real GDP	0.11	0.44	2.35	0.01
GDP deflator	0.87	0.00	1.20	0.76
Core CPI	0.79	0.00	1.70	0.64
Short-term interest rates	0.85	0.00	1.36	0.76
Long-term interest rates	0.92	0.00	0.90	0.89

Notes:

1. Marginal level of significance for estimate of β (probability value).
2. Standard error of the regression (SER).

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